

# Capital Expenditures in Selected Manufacturing Industries, Part II<sup>1</sup>

By Lowell J. Chawner

A rapid enlargement of industrial facilities for military purposes in the United States began in the last few months of 1940. This expansion proceeded through the entire year 1941 and has continued up to the present time. We are probably now entering a new phase in which the urgent need for raw materials, machines, and labor skills for producing finished military supplies will take increasing precedence over the uses of these resources for further additions to productive facilities.

The principal part of the specialized matériel which will be used by American ground and air forces during the first year of our participation in the war, thus, will be fabricated either in new plants constructed during the two-year period from the middle of 1940 to the middle of 1942, or in existing plants converted to this purpose during the past 6 to 12 months. The industrial mobilization of Germany prior to its active participation in large scale combat was spread over a period of approximately 5 years.

During the years 1941 and 1942 a total of possibly 10 billion dollars will have been spent upon total outlays for manufacturing facilities of all kinds, both public and private. This figure may be compared with a rough measure of the replacement cost of all existing manufacturing facilities at the beginning of this period of 50 to 60 billion dollars. These outlays are much larger than in any similar period but are even more marked by their predominantly military character and by their being financed extensively directly by the Federal government.

## Preliminary Summary for 1941

A summary of the capital expenditures during 1941 as well as for the year 1939 in separate manufacturing groups is presented in table 1. It was possible to include in this table estimates for several industries for which similar data are not available for other years.

The 1939 figures which form the bench mark for all of our estimates of manufacturing capital expenditures are derived primarily from the Census of Manufactures returns on plant and equipment expenditures for that year. To these data corrections were made for under-coverage, principally to allow for construction at new manufacturing plants not in operation in 1939 and consequently not reporting to the Census of Manufactures. Allowances were also made for the production of new machinery for leasing account, particularly in the leather and leather products group of industries and for expenditures for plant and equipment by the

Federal government in the printing, publishing, and allied industries; in shipbuilding and ship repairing; and in the ordnance industry groups.

**Table 1.—Capital Outlays for Productive Facilities for Manufacturing Purposes, Public and Private, 1939 and 1941**

[Millions of dollars]

Industry	1939	1941*
Food and kindred products.....	240	330
Textiles, apparel, and related products <sup>1</sup> .....	130	170
Lumber and lumber products <sup>2</sup> .....	60	75
Pulp, paper, and allied products.....	86	85
Printing, publishing, and allied industries.....	58	70
Chemicals and allied products (includes explosives but not ammunition).....	160	660
Products of petroleum and coal <sup>3</sup> .....	140	190
Rubber products.....	33	60
Leather and leather products.....	15	20
Stone, clay, and glass products.....	68	110
Iron and steel and their products <sup>4</sup> .....	190	580
Nonferrous metals.....	45	220
Ordnance and accessories:		
Ammunition, shells, and bombs.....	\$ 4	670
Guns and small arms.....	\$ 6	200
Military combat vehicles.....		60
Machinery <sup>7</sup> .....	140	360
Automobiles and automobile equipment.....	135	120
Transportation equipment except automobiles:		
Airplanes, airplane engines, and parts.....	30	550
Shipbuilding and ship repair.....	\$ 35	400
Other transportation equipment.....	5	10
Miscellaneous <sup>8</sup> .....	40	70
Total capital outlays all manufacturing purposes (public and private).....	1,620	5,010

\*Data for 1941 comparable to those for earlier years were not available at the time this article was written. The figures shown for 1941 are, in most cases, projections from the 1939 and 1940 estimates. They are based upon building construction activity, floor space, and net increases in capacity, together with data upon the completion of war facilities (public and private) through December 1941 reported by the War Production Board.

<sup>1</sup> Includes textile-mill products, apparel, and similar products.

<sup>2</sup> Includes lumber and timber basic products, furniture, and finished lumber products.

<sup>3</sup> Includes petroleum refining, coke and byproducts, and other products of petroleum and coal.

<sup>4</sup> Includes blast furnace, steel works, rolling mill, foundry, hardware, plumbing and other iron and steel products, but excludes guns and small arms. Blast furnaces, steel works, and rolling mills (including cold rolled) establishments accounted for approximately \$110,000,000 in 1939, and \$390,000,000 in 1941.

<sup>5</sup> Includes outlays of approximately \$1,000,000 by private concerns and \$3,000,000 at Army and Navy arsenals.

<sup>6</sup> Includes outlays of approximately \$2,000,000 by private concerns and \$4,000,000 at Army and Navy arsenals.

<sup>7</sup> Includes electrical and other machinery.

<sup>8</sup> Includes outlays of approximately \$11,000,000 by private concerns and \$24,000,000 at Government shipyards.

<sup>9</sup> Includes tobacco.

The additions to manufacturing facilities in 1939, although somewhat less than the average during the 1920 decade, were neither unusually large nor small when compared with recent years.

The first three quarters of 1940 experienced moderate expenditures for industrial facilities in nearly all branches of manufacturing. In the aggregate these outlays were at a rate approximately equal to that in 1937 but less than that in several other years during the period covered by these estimates. As indicated above a sharp advance occurred in the last quarter of 1940.

At the beginning of 1941, capital expenditures were considerable in nearly all branches of manufacturing. As the year progressed, inability to obtain necessary

<sup>1</sup> The first section of this article was published in the December 1941 *Survey of Current Business*.



equipment and materials, particularly metals, sharply curbed all building of new plant that was not essential to the war effort. For 1941 as a whole, about two-thirds of the total manufacturing outlay was in industries engaged primarily in the production of military supplies or of commodities required in their fabrication.

During the present year, 1942, the construction of manufacturing facilities will be wholly determined by military requirements. Projected expenditures for this purpose are somewhat larger than the outlays in 1941. However, in view of the increasing emphasis upon the immediate production of large quantities of finished war supplies it is possible that labor and other resources may be used increasingly for this purpose rather than for the construction of all of the new plants now projected for 1942.

#### Annual Estimates.

Previous articles in the SURVEY have presented estimates of the annual capital expenditures in all manufacturing from 1915 through 1940, and estimates of such expenditures in selected manufacturing industries over the period from 1919 to 1940.<sup>2</sup> The individual industry groups heretofore covered, along with some analysis of the factors which appear to have influenced their capital outlays, are food and kindred products; textiles and related products; lumber and lumber products; pulp, paper, and allied products; printing, publishing, and allied industries; and stone, clay, and glass products.

Estimates also have been compiled on the capital expenditures in certain other industrial groups, some of which are of special interest at the present time. In this issue annual outlays during the past 2 decades are considered for each of six industries: blast furnaces, steel works, and rolling mills; automobiles and automobile equipment; airplanes, airplane engines, and parts; petroleum refining; rubber products; and leather and leather products.

#### Blast Furnaces, Steel Works, and Rolling Mills

Large orders for steel and steel products from the British and French governments early in 1915 together

with an increasing domestic demand and a very considerable shift from Bessemer to open-hearth methods resulted in the greatest expansion in steel-making facilities in 1915 and 1916 thus far experienced in the United States. The net addition to annual capacity for making steel ingots and castings in this country was approximately 5 million net tons in 1915 and 4.3 million net tons in 1916. The corresponding increment in 1941 was slightly more than the latter figure.

Since the first World War, steel-making facilities have been expanded gradually and altogether have been increased by nearly one-half. At the beginning of 1919 the rated capacity for the production of steel ingots and castings reported by the American Iron and Steel Institute was 61 million net tons. At the beginning of the present year, 1942, the corresponding figure for ingots and castings was 88.6 million net tons.

The largest increases in iron-making capacity prior to 1941 occurred in 1917 and 1918. In 1917, 2.3 million net tons were added to the annual capacity of blast furnaces to produce pig iron and related ferro-alloys. In the following year the corresponding figure was 1.5 million net tons. During the period since the first World War appreciable net increases in total iron-making capacity have occurred in only a few isolated years such as 1920, 1926, and 1940. Rated blast furnace capacity at the end of 1918 was 55.2 million net tons and at the end of 1940 it was 57.6 million net tons.<sup>3</sup> Important expenditures were made, however, in some years for the remodeling of old and obsolete blast furnaces or for replacing them with much larger and more efficient units.

In 1941 blast furnace construction resulted in a net gain of approximately 2.8 million net tons in annual capacity, more than that of any other year on record. An even larger increase is in prospect for 1942.

In effecting the developments mentioned above, capital expenditures aggregating approximately 340 million dollars were made in the blast furnace and steel works industry in 1917. Outlays in this industry had not equaled those of 1917 until the past year.

<sup>3</sup> The 1918 figure includes some but an indeterminate tonnage of "long idle" furnaces not included in 1940.

<sup>2</sup> See the *Survey of Current Business*, March 1941, p. 9, and December 1941, p. 19.

Table 2.—Capital Expenditures for Plant and Equipment in Selected Manufacturing Industries,<sup>1</sup> 1919–41

[Millions of dollars]

Industry group	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941 <sup>2</sup>
Petroleum refining.....	75	100	55	Average 65				85	80	120	125	85	65	55	65	70	55	90	144	132	130	132	150
Rubber products.....	70	105	25	23	22	21	29	32	41	38	54	22	17	11	13	16	15	22	32	27	33	34	60
Leather and leather products.....	29	23	14	18	17	15	16	20	17	17	17	12	11	10	10	11	13	15	15	14	15	14	20
Blast furnaces, steel works, and rolling mills <sup>3</sup> .....	160	190	100	100	120	180	200	230	160	200	150	300	120	40	50	40	122	200	316	132	110	156	390
Automobiles and automobile equipment:																							
Depreciable capital expenditures.....	59	171	52	44	87	98	88	111	131	113	150	94	49	37	25	48	99	109	119	112	83	124	80
Total capital expenditures <sup>4</sup> .....	72	187	64	59	105	118	116	140	160	149	186	118	77	69	48	78	130	153	159	155	135	197	120
Airplanes, airplane engines, and parts.....																	5	10	16	12	30	110	550

<sup>1</sup> Includes establishments engaged in manufacturing only as defined by the Census of Manufactures.

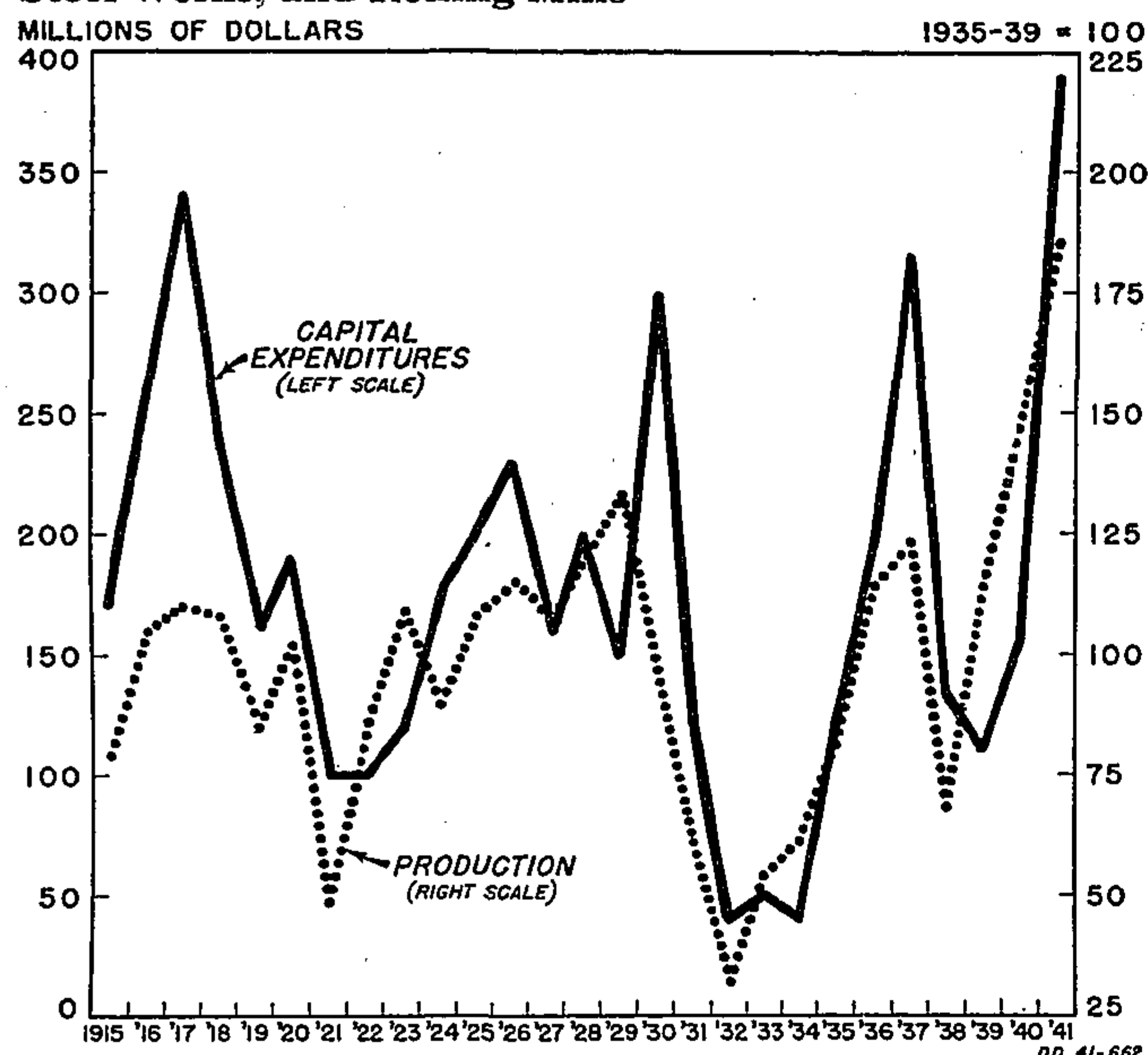
<sup>2</sup> The rough estimates shown for 1941 are based upon incomplete data and may be substantially changed when more adequate information becomes available.

<sup>3</sup> The blast furnaces, steel works, and rolling mills group, as shown above, includes only those specific industries; thus, it does not include foundries and finished wire, tin plate, cutlery, hardware, stamping, structural fabrication, and other iron and steel products establishments. The total capital expenditures in all of the iron and steel industries in 1939 were approximately \$190,000,000 as compared with \$110,000,000 for the blast furnace, steel works and rolling mill industry. Estimates for earlier years corresponding to those shown above for the blast furnace, steel works and rolling mill industry are as follows: 1915—\$170,000,000; 1916—\$280,000,000; 1917—\$340,000,000; 1918—\$240,000,000.

<sup>4</sup> Total capital expenditures in the automobile manufacturing industry, in addition to the depreciable capital expenditures, include nondepreciable tools, jigs, and dies which are considered by many concerns in this industry as capital expenditures but which are subsequently charged off as current manufacturing expense rather than as depreciation on capital assets.



**Figure 7.—Estimated Capital Expenditures for Plant and Equipment and Index of Production for Blast Furnaces, Steel Works, and Rolling Mills**



Sources: Capital Expenditures for all years and Production for 1915-18 estimated by the U. S. Department of Commerce; Production for 1919-41, Board of Governors of the Federal Reserve System.

In view of the lower construction costs prevailing in 1915 and 1916 than in subsequent periods of high activity, the physical additions to productive facilities were relatively greater during these years than is indicated by the dollar figures shown in table 2 and figure 7.

Capital outlays for iron- and steel-making facilities declined steadily for several years after 1917 to a low level in 1921 and 1922. Later in the 1920 decade, the increased demand for steel products—especially for automobile manufacturing and building construction—was accompanied by substantial outlays by the steel companies. This expansion reached a peak in 1930. The precipitous decline from 1930 to 1932 was followed by 2 years in which very few additions were made to productive facilities in this industry.

In many large companies the decline was deeper than that shown for the industry as a whole. Some of the smaller and moderately sized steel companies were able to improve their facilities to a limited extent during this period.

These outlays were again very large in 1937—approximately of the same order of magnitude as those in 1917 and 1930. Complete data for 1941 are not yet available but it may be estimated that the capital outlays for blast furnaces, steel works, and rolling mills were approximately 390 million dollars, considerably more than in any previous year.

The timing of the fluctuations in the outlays in this industry are of special interest. The high and low points in the short-term fluctuations in these outlays do not have a high simultaneous correspondence with those in general business during the period covered by these estimates. The blast furnace and steel works industry thus differs from some of the other industry groups and from the total for all manufacturing.

The reasons for this difference are not altogether clear. In several cases the larger corporations have made unusually large expenditures immediately following years of heavy production and good earnings. In view of the extensive size of many installations, considerable time elapses between the initiation of such projects and the actual expenditures for these purposes. In the main, fluctuations in capital expenditures thus tend to lag somewhat after the fluctuations in the production of steel products.

During the latter part of the 1930 decade, the largest capital outlays in this industry were for continuous, highly mechanized equipment for rolling sheet-steel and for facilities such as electric furnaces for producing special alloy steels to meet the requirements of particular users. In 1937 expenditures upon rolling mill machinery appear to have been more than 50 million dollars and they were from 25 to 30 millions of dollars in several other recent years. The increasing use of electric furnaces for the manufacture of special alloy steels has resulted in important additions to such facilities particularly beginning in 1937. By far the largest increases in electric furnaces have occurred during the past 2 years.

Technological changes in steel products and in their methods of manufacture thus were important underlying influences in determining the outlays in 1935 to 1937. It is hardly likely, however, that the expenditures would have been made if some increases in demand had not occurred during these years. The large outlays in 1941 clearly are due to the war demand and not to any unusual changes in technology.

The additions which are now planned for this industry will result in outlays for blast furnaces, steel works, and rolling mills in 1942 exceeding those constructed during any preceding year. Up to the present a large part of the capital expenditures in this industry have been made directly by the steel companies. In order to meet wartime requirements, approximately four-fifths of the outlays for iron- and steel-making facilities being undertaken at the present time are to be constructed by funds supplied for this purpose by the Federal Government.

### Automobiles and Automobile Equipment

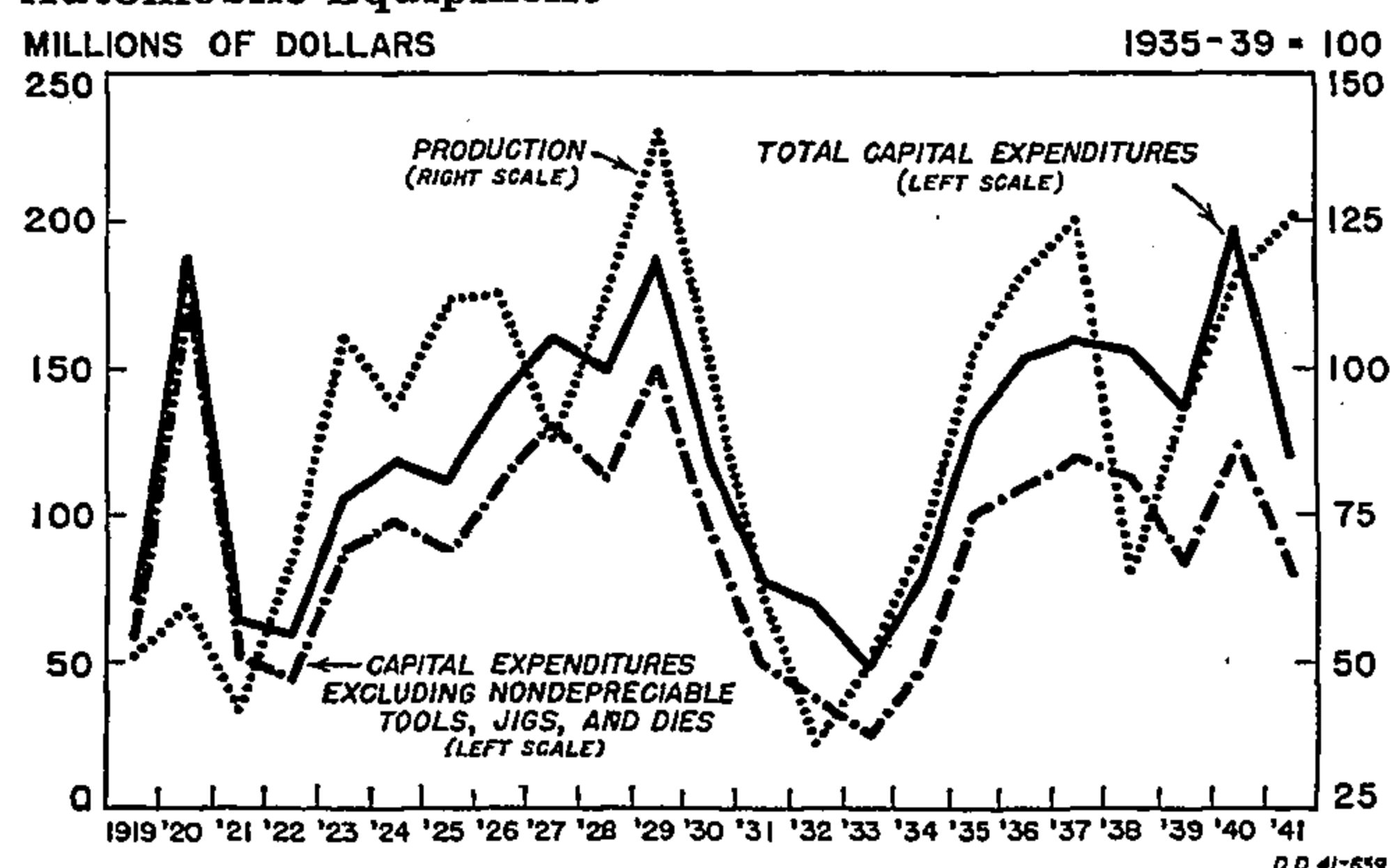
Automobile manufacturing grew from an experimental stage in 1900 to one of the leading industries in the United States immediately after the first World War. Approximately 4,000 vehicles driven by internal-combustion engines were fabricated in 1900 compared with over 2,000,000 in 1920. Today, as is well known, there are more than enough passenger automobiles to transport comfortably the entire population of the United States at one time.

The first decade of this period of development was largely one of improvement in the efficiency and reliability of the automobile and a widening of consumer

acceptance for the new, strange-looking, horseless carriage. From about 1910 through the first World War, notable developments were made in methods of manufacture for the purpose of using capital facilities and manpower more efficiently.

The application to a high degree of the principle of specialization and the minute division of labor, the use of standard interchangeable parts, and the use of line-production methods, as is well known, have been introduced to American manufacturing largely through the automobile industry. The extent of this advance in manufacturing techniques is indicated in the following comparison showing some of the results of these changes over a period of 3 decades.

**Figure 8.—Estimated Capital Expenditures for Plant and Equipment and Index of Production for Automobiles and Automobile Equipment**



Sources: Total Capital Expenditures and Capital Expenditures excluding Non-depreciable Tools, Jigs, and Dies estimated by the U. S. Department of Commerce; Production, Board of Governors of the Federal Reserve System.

In 1910 approximately 2,500 man-hours were required to manufacture a 20-horsepower automobile. Today with the aid of improved power machinery and manufacturing techniques, a much larger and more comfortable automobile which will develop 100 horsepower requires only 500 man-hours for its fabrication.<sup>4</sup> The final cost of the 1941 model car to the consumer was \$1,000 as compared with \$1,500 for its predecessor of 3 decades ago.

In the early years of this industry capital expenditures by automobile manufacturers themselves were relatively small. Automobile manufacturing was largely a process of assembly of purchased parts or completely integrated units such as bodies and motors. The suppliers of parts specialized in the production of valves, bearings, wheels, castings, electrical equipment, and, as just indicated, in some cases complete bodies and motors. Later, after the first World War, automobile companies increased their own manufacturing facilities and in a few cases became very highly integrated. This expansion was financed largely out of current earnings. Up to 1926 as much as 80 percent of the capital expansion in the automobile-manufactur-

ing industry was financed in this manner. This practice has not been substantially changed in recent years, although in a few cases substantial public offerings of automobile-manufacturing securities have been made for the purpose of acquiring existing properties.<sup>5</sup>

Capital expenditures for automobile manufacturing began to be quite large shortly before the first World War and increased sharply during the 2 immediate post-war years. The expenditure of more than 180 million dollars in 1920 was larger than in any subsequent year prior to 1940. The high expenditures in 1920 reflect to some extent the high unit costs for buildings and industrial machinery in that year. Notwithstanding this fact, the rate of additions to automobile manufacturing facilities in 1920 for new buildings and operating equipment other than tools, jigs, and dies, were the largest they have ever been in any year in this industry.

Since that time capitalized tools, jigs, and dies (consumable tools and hand tools are not included) have represented an increasing portion of the total capital expenditures reflecting largely the importance of style changes in automobile manufacturing. In 1920 tools, jigs, and dies represented less than 10 percent of the total capital expenditures in this industry. In 1932 they represented nearly 50 percent of these capital expenditures. The corresponding figure for 1939 was approximately 40 percent for the industry as a whole. Many individual automobile manufacturing concerns made a considerably larger part of their capital expenditures for this purpose in that year.

The fluctuations in outlays for new plant and other facilities for automobile manufacturing parallel to some extent the fluctuations in automobile production and in general business. The recovery from low points in capital expenditures, however, appears to have lagged after the revival in automobile production by one year in terms of the annual totals, as may be observed from the low points in 1922, 1925, 1928, 1933, and 1939 in figure 8. In each cycle the low point in capital outlays was reached in the year after the corresponding low point in production. This is true of the total and of the large companies. Some of the moderately sized companies, however, appear to have experienced fluctuations in capital outlays coincident with those in general business.

Following the low point in total capital expenditures in this industry in 1922, there occurred a steady rise to a peak in 1929, almost identical with that in 1920. Depreciable capital expenditures, however, do not appear to have reached the 1920 level in any year before or since that time.<sup>6</sup> The largest outlays upon capital facilities of all kinds in the automobile manufacturing industry were nearly 200 million dollars in 1940. This

<sup>4</sup> There are some indications that man-hour cost has turned upward in recent years.

<sup>5</sup> See Seltzer, Lawrence H., *A Financial History of the American Automobile Industry*.

<sup>6</sup> See page 22 for distinction between "depreciable capital expenditures" and "total capital expenditures."



expenditure was due especially to large outlays for tools, jigs, and dies.

In view of the extensive production of war materiel by this industry, capital additions for automobile manufacturing purposes declined sharply in 1941.

### Airplanes, Airplane Engines, and Parts

At the beginning of the year 1939 airplane manufacturing was a relatively small industry. Its plant and equipment excluding land were valued at approximately 70 million dollars and the floor space available for manufacturing purposes was slightly more than 9 million square feet. The total value of its products in that year was approximately 280 million dollars, roughly one-half of one percent of the total for all manufacturing. The designing, production, and management personnel in this industry, however, provided a nucleus of marked technical competence which has made the recent expansion possible.

In 4 years, from 1939 through 1942, the manufacture of airplanes, motors and parts will have grown to a gigantic enterprise, 15 to 20 times its size at the beginning of this period. In these 4 years more than a billion two hundred million dollars will have been spent in the United States on new buildings, machinery, and other facilities for the manufacture of airplanes, motors and parts.

The principal airplane production in the United States during the first World War was not in combat but in training planes. The fabrication of these light

turing facilities comparable to those now essential for this purpose. The principal aircraft achievement in the United States during the first World War was the Liberty engine which was produced in large numbers by automobile engine manufacturing companies.

In the immediate post-war years the airplane manufacturing industry suffered an almost complete eclipse. For 1919 the Bureau of the Census reported an annual production of 662 planes and a total value of products in this industry of slightly more than 14 million dollars. The corresponding figures for 1923 and 1925 were slightly lower. A moderate increase occurred in 1928 and 1929. The total value of the products in the latter year of approximately 70 million dollars, however, was only one-fourth of that a decade later at the beginning of the expansion during the present war.

Plant facilities for the production of airplanes do not appear to have experienced any considerable post-war growth until 1928, 1929, and 1930 during which period important additions were made to facilities in this industry. Such data as are available for these years indicate that expenditures for new airplane manufacturing plants during these 3 years may have averaged from 20 to 25 million dollars annually.

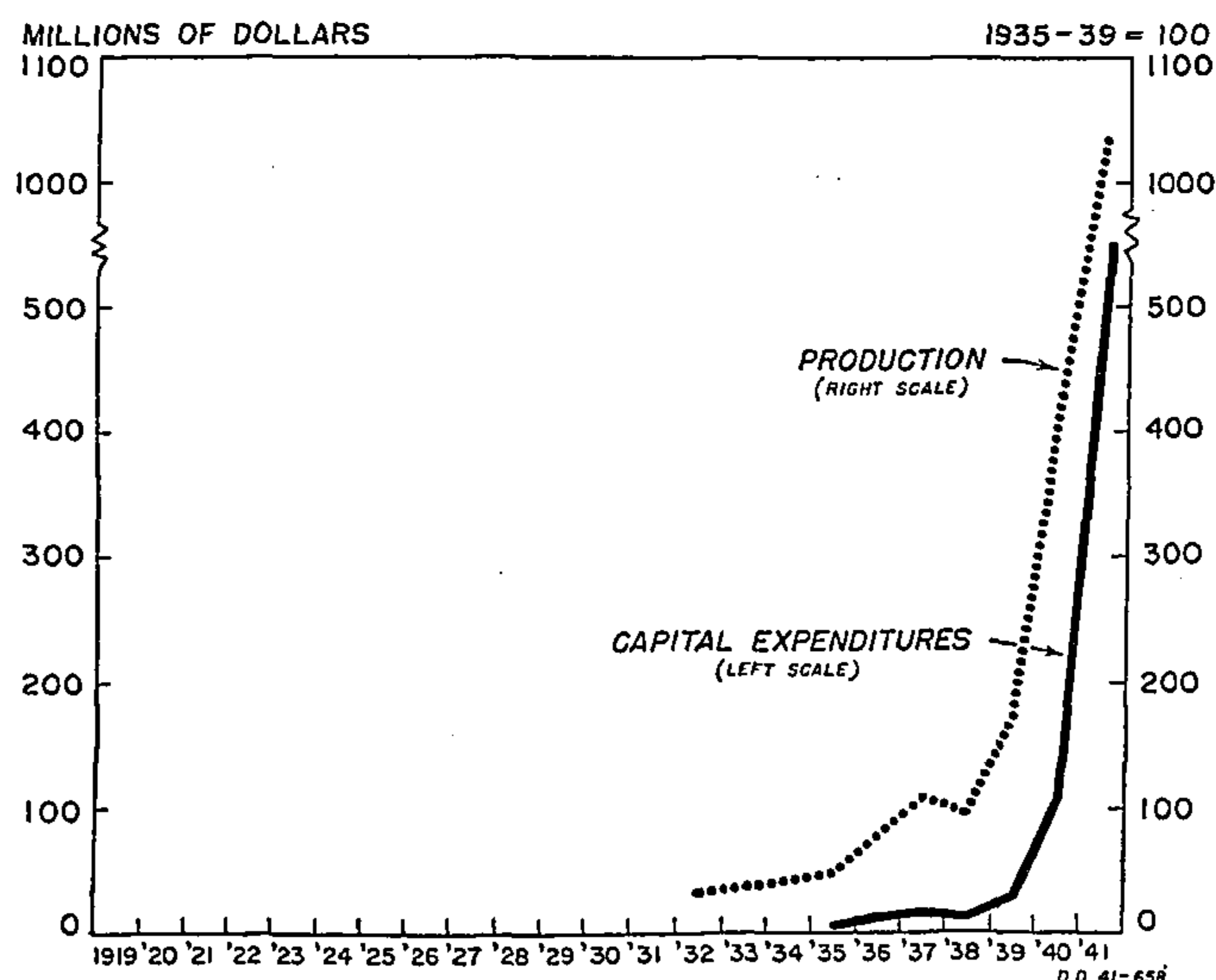
The explosive growth in aircraft manufacturing facilities during the past 3 years is indicated in figure 9. By the end of the present year it appears likely that there will be available approximately 100,000,000 square feet of manufacturing space for the fabrication and assembly of airplanes, motors, and parts by all manufacturing concerns (aircraft, automobile, and other) now engaged in this undertaking. This is the equivalent of a structure 200 feet wide and nearly 100 miles long.

The rate of expansion from a highly competent but small technical nucleus to a great industry employing 800,000 workers, with plant facilities costing approximately one billion three hundred million dollars is an outstanding joint accomplishment of government and business management working together in the preparation of this Nation for war.

### Rubber Products

The 2 years immediately following the first World War experienced by far the largest expansion in manufacturing facilities which has occurred in the rubber products industry. More than 100 million dollars appear to have been spent for plant and equipment by rubber companies in 1920. During the war there had been a shortage of rubber and other raw materials and a curtailment of plant expansion which was not absolutely necessary in the prosecution of the war. Attributable both to a vigorous period of natural growth, and to shortages which accumulated during the war, this industry experienced an active postwar demand for its products in terms of the facilities then available.

**Figure 9.—Estimated Capital Expenditures for Plant and Equipment and Index of Production for Airplanes, Airplane Engines, and Parts**



Sources: Capital Expenditures for 1935-41 and Production for 1941 estimated by the U. S. Department of Commerce; Production for 1932-40, Board of Governors of the Federal Reserve System. Capital Expenditures for 1919-34 and Production for 1919-31 are not available.

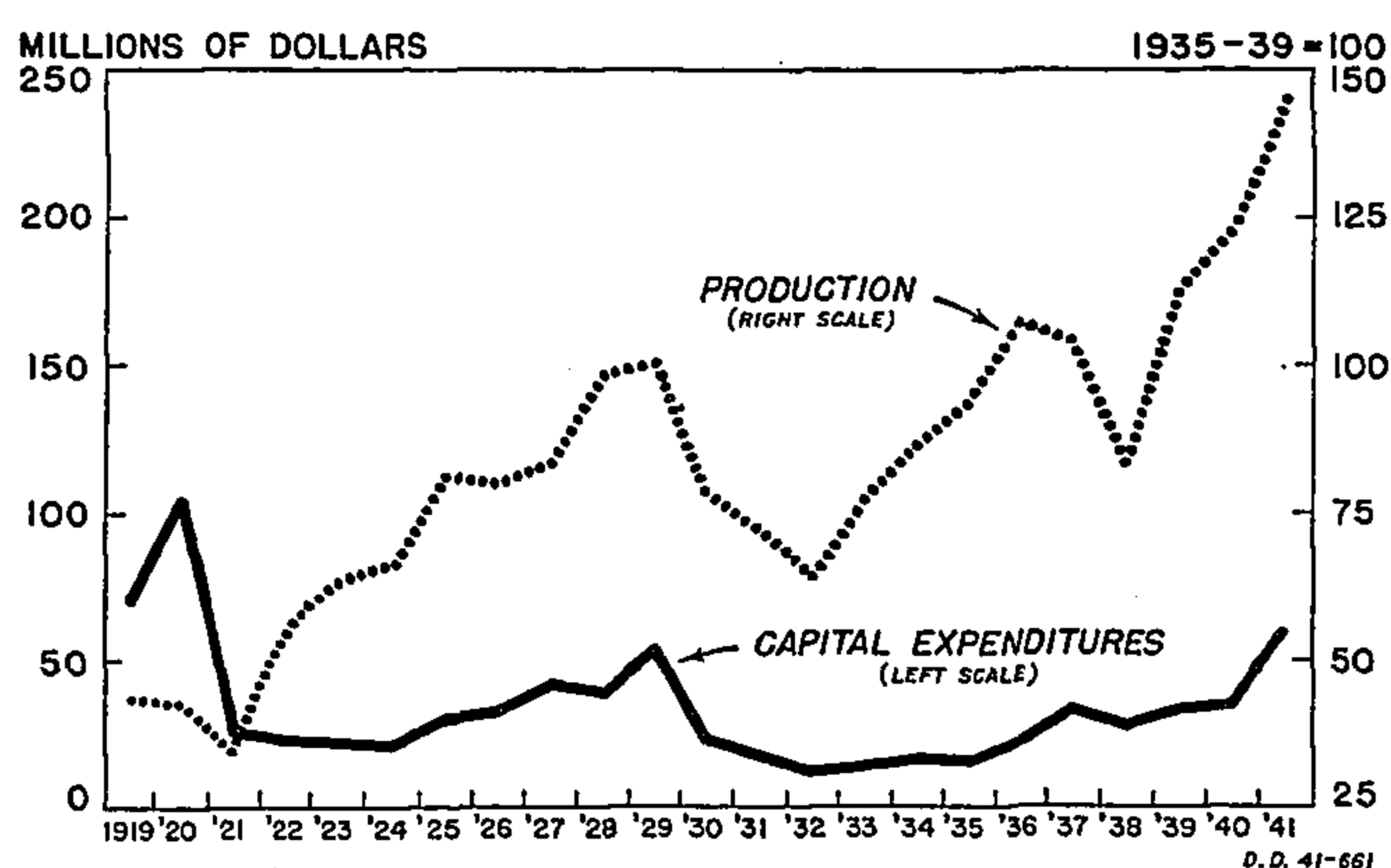
craft, although considerable in numbers (it is estimated that 12,000 airplanes of all types were manufactured in the United States in 1918) did not require manufac-

Also prices were high and the ratio of net profits to gross income has exceeded that of 1919 in only one other year during the past 2 decades.<sup>7</sup> Thus, many factors were favorable to an expansion of capital facilities in the rubber manufacturing industry.

By the summer of 1920, however, it became evident that the immediate postwar plant expansion had exceeded current requirements. Outlays for new facilities, consequently, declined precipitously and remained low through 1924. In view of the excess productive capacity constructed during the immediate postwar years few additions were made until the latter part of the 1920 decade.

Immediately after the first World War the outlays were very largely in the Akron, Ohio, area. From 1927 to 1929 several new plants built in the vicinity of Los Angeles, Calif., accounted for the major part of the expenditures for the building construction included in the totals during these years shown in figure 10.

Figure 10.—Estimated Capital Expenditures for Plant and Equipment and Index of Production for Rubber Products



Sources: Capital Expenditures for all years and Production for 1919-22 and 1941 estimated by the U. S. Department of Commerce; Production for 1923-40, Board of Governors of the Federal Reserve System.

The unusually high expenditures in 1919 and 1920 and to a lesser extent those in 1927, 1928, and 1929 were attributable especially to expenditures for factory building construction in the rubber manufacturing industry. As in nearly all industries the expenditures upon new machinery have been much steadier than the expenditures upon additions to buildings. In 1939 the outlays for new plant (principally buildings and related structures) was approximately 13 percent of the total; in 1920 this percentage appears to have been more than 50 percent of the total.

A reduced level in the physical production of rubber products lasted for several years after 1929. The volume in that year was not equaled until 1936. Since the latter year the capital expenditures in the rubber products industry have varied from approximately 30 million dollars to 60 million dollars annually. As already implied, the outlays included in the totals

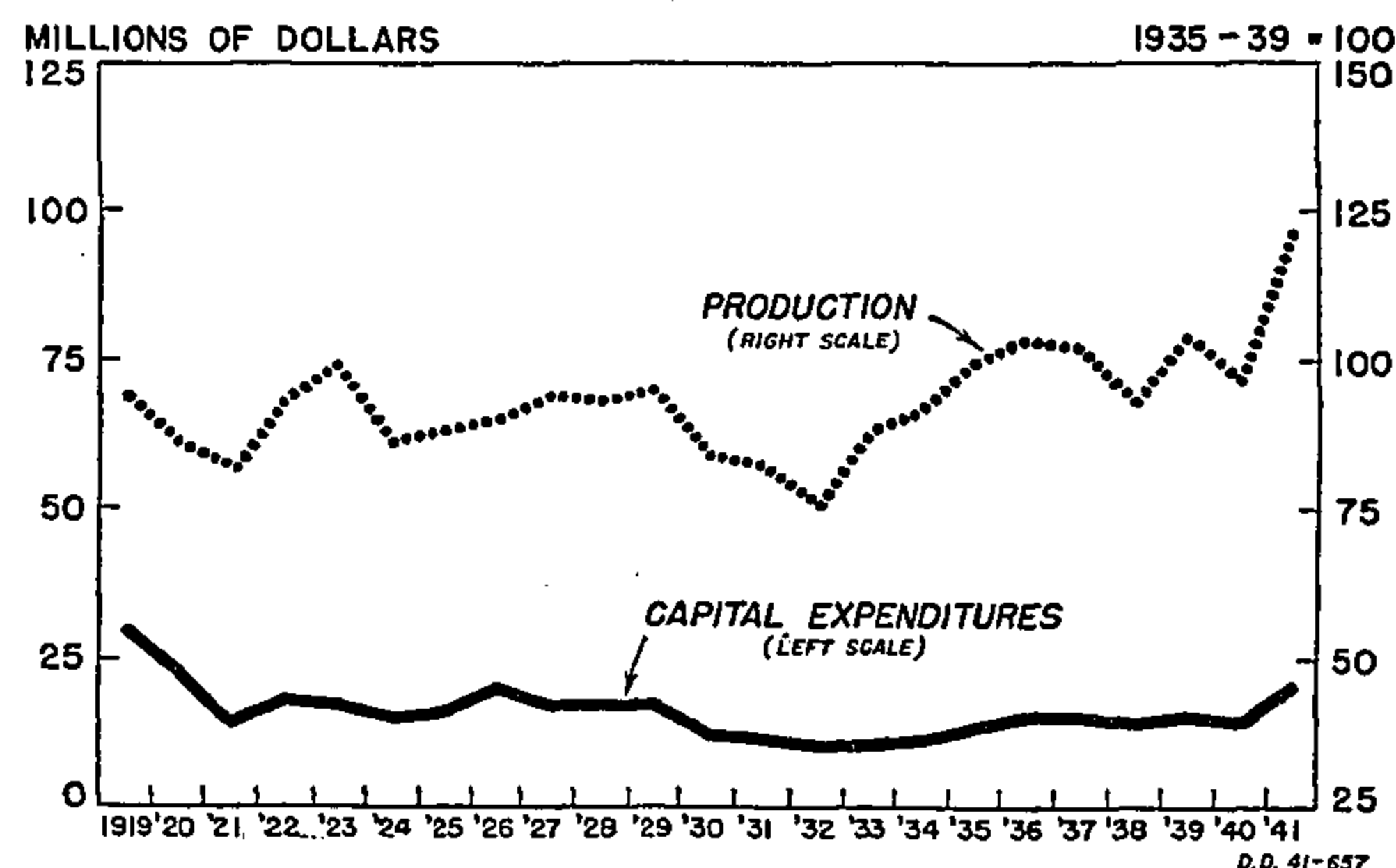
shown in figure 10 and table 2 for the rubber industry in recent years very largely reflect expenditures for new and improved machinery and other equipment rather than for buildings. In view of increased efficiency of this equipment the additions to productive capacity in recent years are relatively larger than would appear from a comparison of the expenditures during these years with those in 1920 and 1929.

The estimates shown in table 2 and figure 10 refer solely to the outlays by the companies in this industry for rubber-working facilities. They do not include new plants for the manufacture of synthetic rubber or for other manufacturing operations not classified by the Bureau of the Census as a part of the rubber products industry.

### Leather and Leather Products

Additions to facilities for the manufacture of leather and leather products have fluctuated much less than

Figure 11.—Estimated Capital Expenditures for Plant and Equipment and Index of Production for Leather and Leather Products



Sources: Capital Expenditures estimated by the U. S. Department of Commerce; Production, Board of Governors of the Federal Reserve System.

those in any other industry considered in these articles. In only 2 years during the entire period covered by these estimates have they been less than 10 million dollars nor more than 20 million. The only outstanding development during this period of 23 years was the relatively high expenditures for this purpose in 1919 and to a lesser extent in 1920. The capital expenditures in these years were due to extensive modernization and consolidation in all branches of this industry and were undoubtedly influenced by the very high profits in 1919, which in that year were higher for this industry than in any other year during the entire period.<sup>8</sup>

The absence of appreciable year-to-year changes in these expenditures may be attributable in the main to two influences, (1) the relatively steady and slightly expanding rate of production of leather and leather products, and (2) the centralized control of the fabrication and introduction of shoe machinery (the major item in the total of these capital expenditures) by a few companies, one of which is responsible for by far the largest part of the total manufacture of this type of equipment.

<sup>7</sup> See Leland Rex Robinson, "Corporate Earnings on Share and Borrowed Capital in Percentages of Gross Income (1918-40)," *Journal of the American Statistical Association*, June 1941, pp. 253-264.

<sup>8</sup> See Robinson, *op. cit.*



### Petroleum Refining

The estimates of capital outlays for petroleum refineries shown in table 2 and figure 12 refer only to manufacturing facilities and do not include plant or equipment used in petroleum mining, storage, transportation, or distribution. The total capital expenditures of the petroleum industry for buildings, machinery, pipe lines, tankers, storage facilities, as well as refineries, are approximately four times those shown in table 2 for petroleum refining.<sup>9</sup>

At the beginning of the present century the major product of petroleum refineries was kerosene, which was used principally for lighting purposes. Gasoline was a troublesome ingredient which contaminated the kerosene and which frequently was thrown away as a waste product. The phenomenal growth in the number of automobiles in use between 1900 and the first World War provided an expanding demand for gasoline and effected major changes in refining practices.

Petroleum refining and automobile manufacturing have experienced many complementary developments. The technical advances which have lowered the unit cost of automobiles have greatly expanded the market for gasoline. Similarly, the design of the modern automobile engines has been influenced at every turn by the type of available fuel.

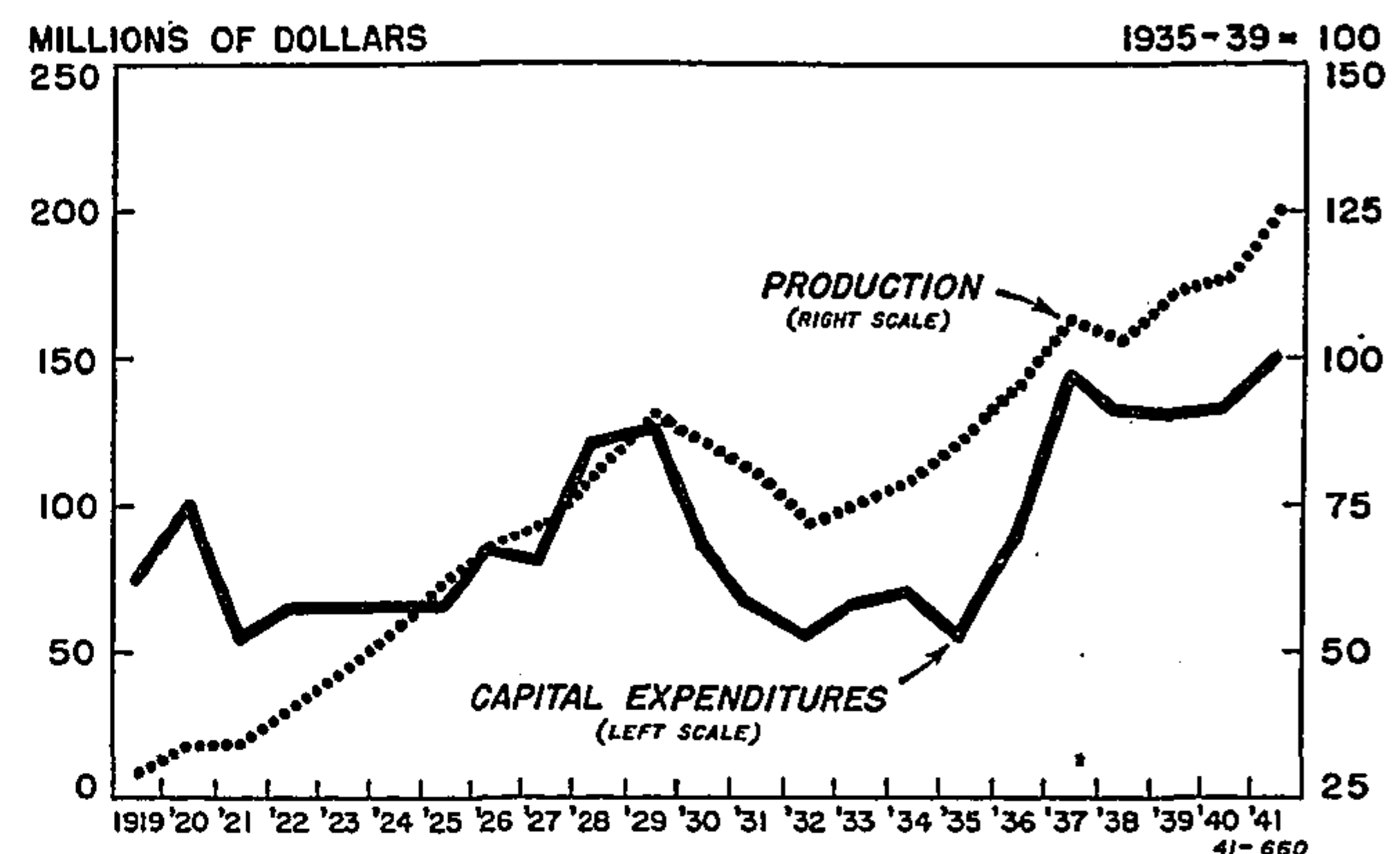
Petroleum refining at the close of the first World War was largely a process of selective distillation of petroleum products, such as the gasoline, kerosene, and lubricating oils, contained in the crude petroleum. Only the amounts of these products actually existing in the crude could be extracted. Today much of our gasoline is made by chemical processes of considerable complexity in elaborate plants designed for this purpose. Crude petroleum is used as the raw material in these plants but other substances containing hydrogen and carbon could be used to serve the same purpose and are being used extensively in Western European countries for the manufacture of gasoline, although at much greater cost.

During the past 23 years petroleum refineries have been expanded to nearly 4 times their throughput capacity in 1919 and have been greatly improved in the technical efficiency in producing particularly gasoline and lubricating oils. The average yield in terms of barrels of gasoline per barrel of crude petroleum has increased from approximately 25 percent in 1919 to approximately 45 percent at the present time. Actually some modern processes, by the addition of hydrogen, yield a larger volume of gasoline than that of the original crude petroleum used for this purpose. From 1919 to approximately 1925 additions to facilities appear to have been largely of the fractional distillation type of plant. In the latter half of the 1920 decade, cracking processes involving both high temperatures and pres-

ures were used to reform some of the substances in the crude petroleum in order to give a higher yield of gasoline.

In the 1920 decade the fluctuations in capital expenditures for petroleum refineries were for the most part similar to those in the automobile, rubber products,

Figure 12.—Estimated Capital Expenditures for Plant and Equipment and Index of Production for Petroleum Refining



Sources: Capital Expenditures estimated by the U. S. Department of Commerce; Production, Board of Governors of the Federal Reserve System.

and several other industries. An abrupt peak in 1920 was followed by a sharp decline and then by moderate outlays during the subsequent 5 or 6 years. Late in the decade the outlays for refineries were again high, particularly in 1928 and 1929. The outlays for petroleum refineries experienced the decline in 1930 characteristic of most of manufacturing processes. In this industry, however, the capital outlays were maintained during these depression years at a level relatively higher than that of any of the other manufacturing groups with the exception of leather and leather products.

Capital facilities play a particularly important part in the process of manufacture of petroleum products. In this industry, as well as in the chemical and allied products industry and food and kindred product manufacturing, the largest part of the value added in the manufacturing processes is attributable to the use of capital facilities rather than to direct labor or other costs.

For approximately 20 years technical changes in petroleum refining have been so rapid that in actual experience the useful life of refineries frequently is as short as 5 years or less. Since about 1936 the practical adaptation of elaborate chemical processes for the manufacture of gasoline such as catalytic cracking, polymerization, and hydrogenation have been conspicuous and have resulted in large capital expenditures for refining facilities.

The intricate refining methods which have developed during the past 2 decades have resulted in the construction of refineries of larger size and in a concentration of such facilities at points outside of the oil fields rather than widely scattered throughout the fields as was formerly the practice. There has been a tendency to

<sup>9</sup> See Temporary National Economic Committee Hearings, part 14-A, p. 7701.



build new refineries, either at collection points on the seacoast near one or more oil fields or to build them close to centers of consumption of petroleum products.

In the year 1941, military requirements have affected the petroleum industry in a number of ways, such as the extraction of toluol from refinery gases, the development of higher octane gasoline for military aviation, and the use of petroleum as a base for synthetic rubber.

### Economic and Other Influences

An examination of the capital outlays in the 12 industries discussed in these articles throws considerable light upon the economic and other influences which appear to have been most closely related to the capital expenditures for manufacturing plant and equipment in the United States over the past 25 years. All of the following factors seldom operate at the same time. However, nearly all manufacturing capital outlays in a given industry appear to be determined in varying degrees by one or more of these influences.

1. The relative importance of capital facilities in a particular manufacturing process (compared with direct labor and other factors of production). For example, in petroleum refining, the chemical industries, and flour milling, the contribution of fixed capital to value added by manufacture is relatively high. In the apparel industries, the leather and leather products industries, and the lumber and timber basic products industries, wages and salaries rather than capital costs are the predominant elements in the value added by manufacture.

2. Technological changes in products and methods of manufacture. Capital expenditures for new facilities are not necessarily made immediately following the practical adaptation of new technological methods but such developments do exert a very strong influence upon the rate of capital expenditures. The replacement of facilities which are essentially identical with those in place is relatively small. Machinery and structures seldom wear out to the extent that they are unable to perform the functions for which they were originally purchased and losses due to fire and other catastrophes in time of peace are not appreciable. Effective demand for nearly all types of durable goods thus is established not as the result of complete wearing out of such facilities, but as the result of a process of obsolescence and the development of improved units which are more efficient than the units previously in place.

3. The rate of physical production of a given commodity relative to previous levels and to the availability of facilities for this purpose at any given time. Extreme urgencies in the requirements for public purposes, such as for military supplies in 1917 and 1918, and at the present time, also may result in unusually large direct public expenditures for industrial facilities.

4. The profitability of some of the enterprises in a given industry. The concern in an industry which is

most profitable is not always the one which expands its facilities or adds new equipment. Such expenditures, however, are much more likely to be made if it is known or believed that one or more concerns in that industry have found profitable the introduction of a particular type of equipment. Thus, capital expenditures frequently are made by a given concern to enable it to compete more effectively with one of its more venture-some competitors.

5. Industrial migration from one region of the country to another due to local differences in power resources, labor costs, industrial relations, State and local taxes, availability of materials and skilled workmen, and similar factors.

6. The availability of labor, materials, and equipment, and their relation to construction costs generally throughout the country. Changes in machinery costs and construction costs appear to have relatively less effect upon expenditures for manufacturing capital purposes than they do upon outlays for office buildings and residential structures.

7. The attitude of individual enterprisers with regard to the outlook for the future.

8. Government policies relating to taxation (tax rates, depreciation, amortization, and the reinvestment of net income) and to the public ownership of production facilities, and similar problems. For example, in the calculation of net income, the Revenue Act of 1918 made possible complete and rapid depreciation charges for the replacement of all machinery and other plant facilities which had been required in the prosecution of the war. This provision was one of the factors stimulating capital expenditures for new plant and equipment in 1919 and 1920.

### Special Significance of Technological and Other Changes.

Change and differences in the rate of growth of particular industries are marked characteristics of the economic history of all modern industrial societies. In the United States changes in products and methods of fabrication have been extensive not only in manufacturing but also in mining, transportation, and other industries, and have greatly influenced many professional services and the modes of domestic living. Even over short periods of little more than a decade, changes of this character have frequently been very far reaching. The following paragraphs illustrate technical changes of this character.

The practical development of the internal combustion engine about the turn of the present century and its revolutionizing effect upon land transportation is well known. Important improvements in this type of engine continue to be made. For example, the high-compression Diesel engines now being sold commercially and the most advanced carburetor engines for airplanes have approximately twice the thermal efficiency of standard automobile engines; also the most



advanced airplane engines weigh less than 1 pound per horsepower compared with 10 pounds per horsepower for most automobile engines.

Recent improvements in metal-cutting tools using tungsten carbide have greatly advanced the progress which has been taking place for several decades in the cutting speeds of lathes and other machine tools. These new tools require heavier machines and greater power, and, thus, increase the rate of obsolescence on existing metal-cutting machines.

The reciprocating steam engine which was perfected in substantially its present form by Watt and Bolton at the beginning of the 19th century, might appear to be an exception to this rule. Actually, however, this prime mover has been largely replaced by steam turbines for power generation and by electric motors for direct application of energy. The steam locomotive—one of the last stands of this type of engine—is rapidly giving way to electric and Diesel-electric locomotives, particularly the latter.

Electricity, first used as a means of developing mechanical power in manufacturing shortly after 1880, is now the energy source of approximately 85 percent of the horsepower capacity of the units from which mechanical power is derived in manufacturing plants in the United States.

Steel at the close of the Civil War was an expensive metal having limited uses for industrial purposes. The production of 83,000,000 net tons in the United States in 1941 is 4,000 times that of 75 years ago.

Aluminum was a rare substance of the scientific laboratory 60 years ago. In the next few years it appears likely that considerable more than one billion pounds of this metal will be produced annually in the United States.

Changes such as these are not the exception but are characteristic of industrial history during the past two centuries. Although difficult to measure, such changes have influenced greatly the rate of expenditures by manufacturing concerns upon capital facilities.

### Methods of Deriving Estimates

The estimates of capital expenditures shown in table 2 and figures 7 to 12 of this issue and similar estimates in the March and December 1941 issues of the SURVEY have been compiled with considerable care and all known statistical data relating to manufacturing capital outlays have been examined. In every case the data which appear to measure such expenditures most accurately have been used. It is necessary, however, to emphasize again, as was done in the earlier articles, that these estimates are not precise additions of reported dollar-expenditures by all manufacturing establishments in a given industry. See Survey of Current Business, March 1941, page 15, and December 1941, page 26, for discussion of methods of deriving estimates of manufacturing capital expenditures.

The methods used in deriving the estimates for each of the industries shown in table 2 are indicated briefly below. The rough preliminary estimates for 1941 appear reasonable in the light of information available at the time this article was written but may be subject to change as more adequate data become available.

### Blast Furnaces, Steel Works, and Rolling Mills

Two entirely independent methods were used in compiling estimates of the capital expenditures in this industry. The first series was secured from direct reports of such expenditures by a number of steel companies in the United States. Over the period from 1935 to 1940 the additions to capital at cost for the principal companies are available in their reports to the Securities and Exchange Commission. The corporations reporting in this manner accounted for 85 percent of the capital outlays by all iron and steel companies in 1939, as estimated from the Census of Manufactures in that

year. Detailed corrections were made for each company for the additions to capital attributable to the acquisition of existing properties from other concerns. The annual totals for all of these companies thus derived were used to measure the year-to-year changes in capital expenditures by all iron and steel establishments in the United States.

Over the period from 1915 to 1934, data upon capital expenditures were secured from five of the larger companies (four prior to 1930), including the two largest in this industry. These reports show the expenditures for manufacturing facilities separately from those used for transportation, mining, and other operations. These five companies accounted for approximately 55 percent of the capital expenditures of the blast furnace, steel works, and rolling mills industry in 1939.

In view of the consolidations which have taken place in this industry over the past 25 years, continuous series based upon capital expenditures of a given corporation represent a much smaller part of the total industry in the earlier years than they do at the present time. Consequently, an attempt was made to trace the subsidiaries and other acquired units of present existing corporations back to the beginning of the period. The only data available for this purpose are the total assets of parent corporations and acquired subsidiaries. Consequently, for this purpose it was assumed that the outlays for new facilities by acquired subsidiaries in earlier years bore the same proportion to those of the parent company as their total assets did to those of the parent company. The simple addition of the reported dollar-expenditures of corporations bearing a given name throughout the entire period would have resulted in serious underestimation of capital expenditures in the earlier years.

A second, entirely independent, estimate of capital expenditures in the blast furnace, steel works, and rolling-mill industry was based upon the annual gross increments in blast furnace capacity (new furnaces and rebuilt furnaces were treated separately) and in the various types of steel-making capacity as reported by the American Iron and Steel Institute. To each of these increments were applied relative weights which were intended to measure the relative unit costs of additions to these various facilities.

The series of annual relatives thus derived, measuring the physical additions to iron and steel-making capacity, was multiplied by an index of construction costs to give an index of dollar expenditures for iron and steel-making facilities. This index was calculated from several separate indexes of actual construction costs compiled by the Interstate Commerce Commission for various types of industrial machinery and structures. To this product of additions in facilities times construction costs were added year-to-year measures of expenditures for rolling-mill machinery derived from the production of such machinery reported in each biennial census year beginning in 1925. In the earlier years the expenditures upon rolling mills were assumed to be proportional to expenditures upon all other additions to capacity in this industry. The series derived in the above manner were used to calculate the year-to-year changes in capital outlays for iron and steel-making facilities.

As in the estimates for other industries, the capital expenditure reported to the Bureau of the Census in 1939, plus allowances for undercoverage in the census returns (13 percent for this industry), was used as the base for the estimates throughout the entire period.

In general, the estimates derived from reported expenditures (the first method) tend to fluctuate more widely than the series based upon annual gross additions to productive facilities (the second method). The movements of the two series, however, were closely parallel and the turning points, with one or two exceptions, occurred in the same years. The long-time trends in the two series also were closely parallel. In nearly all cases discrepancies between the two series appear to have been accounted for by expenditures of companies which were not reflected in the first series but were covered by the second.

In view of the fairly satisfactory coverage of the estimates based upon reported expenditures from 1929 to 1940, the estimates based upon this method were used over this period. For the years prior to 1929 the second method, which reflects additions to facilities by all companies both large and small, appeared to be preferable to the first method. The estimates shown in table 2 over the period from 1915 to 1929 are consequently based upon the second method.

### Automobiles and Automobile Equipment

The year-to-year changes in this series are based upon the fluctuations in the total capital expenditures, including buildings, machinery, tools, jigs, dies, and other productive facilities by seven automobile manufacturing companies including the three largest corporations in this industry. These seven corporations accounted for approximately 85 percent of the estimated total depreciable capital expenditures of all automobile and automobile equipment manufacturers in 1939.

Two series are shown for this industry, (a) total capital expenditures and (b) depreciable capital expenditures. The total capital expenditures in this industry for the base year 1939 included allowances for tools, jigs, and dies in addition to the depreciable capital expenditures reported to the Bureau of the Census. This special distinction is necessary because of the accounting treatment of tools, jigs, and dies by many concerns in this industry. The usual practice in most manufacturing is to depreciate all items charged to capital plant and equipment accounts. The frequent style-changes in the automobile industry have resulted in a practice followed by many companies of charging tools, jigs, and dies to capital accounts but of subsequently writing them off as current manufacturing expense month-by-month during the period in which they are used. Although included in the Census reports of capital expenditures in most other manufacturing industries, the expenditures for tools, jigs, and dies were not reported by the automobile manufacturing companies to the Census of Manufactures in 1939 unless charged to depreciable capital accounts which, as just noted, is not the practice usually followed in this industry.

The Census total for new depreciable plant and equipment expenditures in this industry in 1939 was approximately \$75,089,000. Data received from six of the seven



corporations showed capitalized tools, jigs, and dies separately from the depreciable capital outlays. After a careful examination of the data for the seven corporations representing 85 percent of the capital expenditures in this industry, it has been estimated that the total capital outlays for the automobile and automobile equipment industry in 1939 were approximately 136 million dollars, and the depreciable capital outlays 83 million.

### Airplanes, Airplane Engines and Parts

The most satisfactory measure of the capital outlays in this industry appear to be the additions to capital at cost reported annually to the Securities and Exchange Commission by nearly all of the principal airplane manufacturing companies in the United States. A detailed examination was made of the reports of each of these companies in each year. Based upon this examination a series was compiled showing the additions to capital at cost for new manufacturing facilities by these companies excluding land and transportation facilities. Adjustments were also made to exclude any capital additions due to changes in corporation accounts other than those due to additions to new facilities at cost.

These reports are available only for the period 1935 to 1940, inclusive. The estimate for the year 1941 was derived from (a) statistics upon capital expenditures for industrial facilities compiled by the War Production Board, (b) statistics of building contracts awarded, and (c) floor space in airplane manufacturing plants compiled by the Aeronautical Chamber of Commerce (plus allowances for airplane manufacturing plants operated by corporations whose business formerly had been in other industries).

### Rubber Products

The year-to-year changes in the capital expenditures in this industry were estimated by adding a series measuring building construction activity to a series measuring specialized general purpose machinery (see above references to earlier articles for more detailed description of this general method).

The machinery estimates for biennial census years were derived from the production of special purpose rubber-working machinery reported in the Census of Manufactures plus appropriate allowances to the rubber-products industry of general purpose machinery such as engines and motors. The estimates of machinery expenditures in the intercensal years were interpolated using the gross sales of three concerns (five in earlier years) specializing in the fabrication of rubber-working machinery. Although these companies were responsible for only about 20 percent of the total of such machinery produced in 1939, the fluctuations in their gross sales were in good agreement with the total production of rubber-working machinery reported to the Census of Manufactures in the odd-numbered years throughout the entire period with the exception of the intercensal period from 1919 to 1921 for which special calculations were made. The strikingly high estimate for the year 1920 is attributable to unusually high building construction activity, rather than to unusually high machinery expenditures, although both reached their peak in that year.

The estimates of plant and equipment expenditures derived in the above manner were used to calculate the year-to-year changes in such expenditures in the rubber products industry. The estimate for the base year 1939 was derived from the reports to the bureau of the Census in that year plus allowances for undercoverage and under-reporting in these reports (17 percent estimated for this industry).

### Leather and Leather Products

The year-to-year changes in the capital outlays shown in table 2 for leather and leather-working industries were derived by adding estimates of building construction activity to estimates of production of specialized and general-purpose machinery as previously described for other industries.

The 1939 estimate which was used as the base for the estimates in all years was the capital expenditures (excluding land but including used equipment) reported by all leather and leather products establishments to the Bureau of the Census plus an allowance of 8 per cent for underreporting and undercoverage plus 4 million dollars for

new shoe working machinery which moved into the leasing stock of the principal shoe manufacturing machinery companies. In view of the widespread practice of leasing shoe machinery, the latter adjustment was essential. This figure was derived after a detailed examination of the corporation records of the principal manufacturers engaging in this business and an examination of the Census of Manufactures returns for the leather and leather products industry.

### Petroleum Refining

For the years 1935 to 1940, measures of the additions to capital at cost for the manufacturing or refining divisions of 18 of the principal petroleum companies are available in the reports by these companies to the Securities and Exchange Commission. These statistics were supplemented by similar data from two large corporations for which this detail was not reported directly to that Commission. These 20 companies operated approximately 77 percent of the refining facilities in 1938 and are estimated to have been responsible for about 85 percent of the capital outlays for refineries in 1939. The estimates shown in table 2 for petroleum refineries over the period from 1935 to 1940 are based upon the reports from these 20 companies plus an allowance for the smaller companies for which such data were not available.

Estimates derived in the indirect manner indicated below resembled very closely those based upon reported outlays for refineries by petroleum companies over the period from 1935 to 1940.

Over the period from 1919 to 1934 the year-to-year changes in the capital expenditures for petroleum refineries were derived from the gross annual increments in refining and cracking capacity multiplied by an index of construction costs and by a rough measure of the effect of technological changes upon the costs of new refining facilities. The year-to-year additions to refining and cracking capacity were derived by a year-to-year comparison of the capacity of each petroleum refinery in the United States reported by the Bureau of Mines. These reports upon the total capacity of each refinery are available for January 1 of each year from 1918 to 1941 with the exception of the 2 years 1923, and 1924. Consequently, it has not been possible to calculate the year-to-year fluctuations from 1922 to 1925. An annual average for these years, however, has been compiled.

Annual reports of cracking capacity are available for January 1 of each year from 1928 to 1941. In January 1928, 40 percent of the refining facilities in terms of throughput capacity had cracking as well as refining units. In 1919 cracking was used only at a very few refineries. It was assumed that the ratio of total refining capacity which had cracking units increased in a straight line relation from zero in 1915 to 40 percent in 1928.<sup>10</sup>

In view of the increasingly complicated character of the new units constructed in recent years it was necessary to make an adjustment in order that the estimated capital outlays would reflect such changes. The most satisfactory measure which in a rough general way corresponds to these technical changes is the average octane rating of gasoline produced in the United States.

The final series measuring year-to-year changes in capital outlays for refineries from 1919 to 1934, consequently, reflects gross annual increases in refining plus cracking capacity (2.5 times refining plus 1.0 times cracking) multiplied by an index of construction costs, multiplied by an index of octane rating referred to above. The index of construction costs was derived by consolidating several indexes ("elevated structures", "fuel stations", "shops and engine houses", "gas-producing plants", and "powerplant machinery") of actual costs compiled by the Interstate Commerce Commission, those most closely resembling types of construction in petroleum refineries.

The author will greatly appreciate any suggestions for improvements in these estimates or in the analysis of related influences by persons having special knowledge upon capital outlays in any of the manufacturing industries treated in these articles.

<sup>10</sup> See page 7802, Part 14-A, Temporary National Economic Committee Hearings, total quantity of gasoline produced by straight run and by cracking by years 1920 to 1938.